UBC Social Ecological Economic Development Studies (SEEDS) Student Report

Patio Heaters

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EXECUTIVE SUMMARY

The Perch is an AMS owned rooftop restaurant in the new student union building. The patio was originally only meant for summertime use, however AMS would like to extend patio use into the spring and autumn seasons. Conventional restaurant standard is to use propane heaters but due to the new LEED certification requirements, sustainability is the main priority. Therefore the purpose of our investigation was to discover or create a heating option for the Perch patio that would surpass propane heaters in sustainability. Evidently, the requirements also entailed that the solution had to be economically viable and socially acceptable. In other words, the outright cost of the solution as well as the maintenance and implementation must be outweighed by the return, and the solution must keep the public satisfied and comfortable.

Solution constraints regarding implementation were given by Chiyi Tam during the Sustainability Project Workshop. Chiyi stated that the solution would require little to no structural implications as the solution would be implemented post construction and the SUB opening was already delayed as it is. This lead to another constraint, since structure integration would not be allowed, the solution must not obstruct the staff or customers, or become a tripping hazard. Chiyi also mentioned that since the patio setup would be dynamic, the solution was required to be either mobile, or unaffected by a change in the setup.

To recap, the overall intent of our investigation was to discover, repurpose or create a heating solution for the patio. This solution must be financially feasible, socially acceptable as well as be non-structural, unobstructive and unaffected by any changes in the table layout.

Our investigation consisted of research into three core solution categories: Mainstream heating appliances, alternative fuel sources and applications, and outside the box scenario analysis. During an APSC 261 assignment, we were requested to provide ten references, five of which were peer-reviewed. We took this as an opportunity to assemble a list of references on several different technologies and applications that could potentially be developed into a functional and sustainable solution. After the list was compiled, we assessed the options we had found and narrowed the list down to three unique technologies.

The three technologies are the following:

- Photovoltaic panel charging stations (Solar Panels)
- Infrared heaters
- Kitchen heat exhaust recycling

Solar energy systems provide clean energy which can be stored for later use. Excess can also be sold to BC Hydro increasing profits. AMS LEED certification goals would also highly benefit from such a sustainable solution. Though local applications suggest that solar use has the potential to succeed, from a financial standpoint, the solution may not be viable though long term benefits may outweigh the cost.

Infrared heaters provide quiet, fast, and efficient heat. They come in varying sizes which is valuable with limited structural implementation. Additionally, as infrared heaters can be powered with electricity, environmental impact is minimal. The financial analysis gave positive findings demonstrating a surprisingly low short term cost.

Kitchen exhaust recycling is a recently developed technology that is slowly growing in popularity. The exhaust could be filtered with common air filter techniques such as active carbon filtering to provide clean hot air to patio occupants. This solution would be repurposing previously wasted energy and thusly would be providing a dual effect, lessening environmental impacts by the SUB as well as contributing to the LEED certification with an exponential factor. Implementation would be the greatest obstacle and though heat distribution effectiveness may also be a concern.

After considering all the findings from above, we have decided that the best solution for the Perch would be a two part concurrent system. This system would consist of a ventilation duct that would repurpose wasted heat exhaust from the restaurants kitchen, filter any volatile organic compounds such as unwanted smells and/or chemicals and direct this heat onto patio occupants. This repurposing system would be working in tandem with the second part of the solution, infrared heaters. These heaters would ideally be mounted along the restaurants wall above the doors to avoid any hindrance. They are efficient, effective and can be powered by electrical plugins and would supplement the ventilation heater to ensure customer satisfaction. That being said, increased insulation on the ventilation ducts would ensure less heat loss making the primary system much more effective and thusly reducing energy costs from the infrared heaters. With the combination of the two heaters, customers would be sufficiently comfortable enough to enjoy their patio experience without any problems due to temperature. The platinum SEED accreditation would also benefit from the repurposing of wasted energy, and a sustainable SUB could be leveraged to promote AMS branding. A more detailed assessment of our investigation can be found below.

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LIST OF ILLUSTRATIONS

LIST OF ABBREVIATIONS

UBC - University of British Columbia

VOC - Volatile Organic Compound

TBL - Triple Bottom Line

LEED - Leadership in Energy and Environmental Design

SEEDS - Social Ecological Economic Development Studies

1.0 Introduction

The Perch restaurant, located on the top floor of the AMS Student Nest, has requested an alternative way to heat their rooftop patio. The current solution used within the restaurant industry consists of multiple propane heaters dispersed throughout a seating area providing optimal heat at the expensive of the environment. Chiyi Tam, the stakeholder for the Perch outlined the following key aspects when investigating a potential solution:

- Price Point
- Portability
- Limited labour and maintenance
- Environmentally friendly

With the Perch located in the new Student Union Building, the solution investigated must not reduce the current LEED gold certification. LEED, Leadership in Energy and Environmental Design, is an internationally recognized green building certification system that provides third-party verification of sustainability. Following the LEED guidelines provides a standard to evaluate the environmental effects of a solution. Using a tiered system based on points, certain levels of LEED certification can be achieved, these various levels are based on:

- Sustainable site development
- Water efficiency
- Energy efficiency
- Materials selection
- Indoor environmental quality

As of 2008, the University of British Columbia (UBC) has mandated that all new construction must comply with LEED gold certification status. With this mandate already in effect, the solution proposed must not detract from this certification status. In order to improve UBC's sustainable practices the stakeholders indicated a secondary goal of the Perch achieving LEED platinum status. Reaching this platinum status will not only involve using the triple bottom line assessment but will also incorporate discovering new methods of energy management and innovating on current solutions already used in the industry.

The primary goal of the project is to extend the patio hours of operation, and maintain a positive net revenue effect. In other words, the solution must be cost effective and energy efficient enough that the added income stemming from the extended hours of operation would outweigh the solutions implementation. A major limitation that was added by Chiyi was the fact that the solution implemented could not be integrated into the structure of the building. This limited the solution to a much smaller range of implementations as it meant that no form of fuel or energy, that is not already present, could be allocated specifically. This also meant that the solution could not be built into the patio to solve potential problems such as aesthetics, obstruction or application. Due to this complication another constraint arises, it would have to be either portable or non-obstructive so that the layout and table arrangement could be changed at any time.

Taking these constraints and goals into account, the solution proposed must be a non-structural sustainable solution that would extend patio hours of operation while satisfying customer comfort. With large obstacles to overcome, the stakeholders indicated that creative and innovative solutions would be encouraged and we should not constrain ourselves to traditional heating solutions.

2.0 Method

With a clear goal and a set of requirements set out by the stakeholder, the optimal solution is finding a heating solution with the highest rate of sustainability that work within the constraints set by the Perch's unique circumstances. With many heating solutions already implemented in various food and dining establishments, the bulk of our research consisted of investigating fuel and energy sources to determine what energy source would be the most effective. The data for each comparing the various fuel sources was sourced from manufacturer datasheets and a variety of peer-reviewed articles in order to provide valid results. No primary sources were used during our investigation as this information does not tend to be common knowledge.

Investigation into outdoor heating solutions were divided into three categories, mainstream heating appliances, alternative fuel sources, and creative solutions. Analyzing mainstream heating appliances consisted of researching common patio heaters used in the industry regardless of the environmental aspects. This research led to looking into three main heaters: propane heaters, infrared heaters and natural gas heaters. While investigating alternative fuel sources, green energy sources were examined to determine if new fuel sources could be used in The Perch. With The Perch located on the top floor of the new student union building, solar, wind and hydroelectric energy sources were researched. The goal of this was to discover if traditional propane heaters could be replaced with electric heaters powered by The Perchs own sustainable energy source. Lastly, using the existing research and brainstorming within the team, innovative solutions were devised and investigated with the aim of creating a unique solution taking into account the goals and constraints of The Perch. This method uncovered heating systems that recycled wasted energy and heat involving no net increase in energy usage.

3.0 Analysis & Results

After conducting an initial investigation into each category, the most viable solutions were selected to further research and to analyze in depth. The following list consists of the solutions chosen at this initial stage that fit into the constraints and goals set out.

- Photovoltaic Panels
- Infrared Heaters
- Kitchen Exhaust Recycling

A breakdown of each solution is provided below.

3.1 Photovoltaic Panels

The goal of using photovoltaic panels was to install a solar energy system on the roof of the SUB that could power the Perch's rooftop patio heaters directly as well as contribute to the AMS LEED certification goals. This innovative solution has been implemented for a number of applications locally suggesting that solar use in Vancouver has the potential to be profitable. With an estimated growth rate of 80-130 gigawatts in the the north american residential and commercial market over the next 5 years, a large number of people are turning to solar energy generation. An economic analysis for the Perch is provided below, depicting initial and future costs.

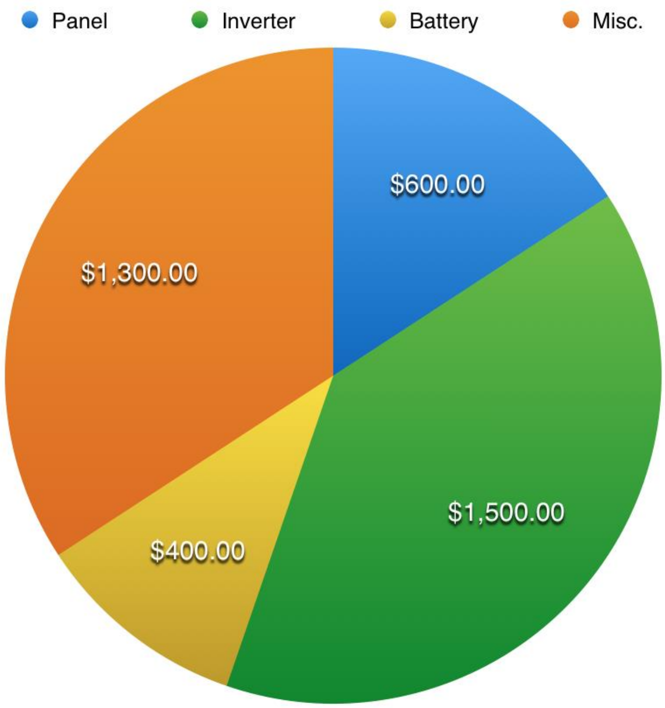

Chart 3.1: Economic breakdown

3.2 Infrared heaters

Infrared heaters provide quiet, fast, and efficient heat. Manufactures provide a variety of sizes and shapes to fit any application which fits the structural constraints provided by the Perch. Additionally, as infrared heaters can be powered with electricity, the environmental footprint generated from BC Hydro is minimal. An economic breakdown and a monthly cost analysis is provided in the chart below.

Pricing Model	
Avg. Food Bill	$18.00
Avg. Customers per Hour on Patio	20
Number of Heaters	12
Additional operation hours	5
Heating Costs	
Unit Cost	$876.00
Total Cost	$10,512.00
Hourly Cost	$0.67
Maintenance Cost / month	$8.76
Revenue	
Extended hours operation	$54,000.00
Extended Hours Heating Cost	$1,311.12
Monthly Net	$52,688.88

Pricing Model	
Avg. Food Bill	$18.00
Avg. Customers per Hour on Patio	20
Number of Heaters	8
Additional operation hours	5
Heating Costs	
Unit Cost	$1,032.00
Total Cost	$8,256.00
Hourly Cost	$1.40
Maintenance Cost / month	$10.32
Revenue	
Extended hours operation	$54,000.00
Extended Hours Heating Cost	$1,762.56
Monthly Net	$52,237.44

Table 3.2: Pricing Model for Infrared (left) versus a baseline propane solution (right)

As seen above, the estimated cost and breakdown for implementing a infrared based heating solution is similar to a propane solution, a industry standard used in many establishments. Even though a higher number of units are required, this is offset by the lower unit cost.

3.3 Kitchen Exhaust Recycling

With the average commercial kitchens internal temperature ranging from 21.0℃ to 37.5℃, excess heat is often forced out of the environment and into the external atmosphere. Creating a recycling system would use this wasted energy as a fuel source to heat customers on the patio. Implementing this solution to reuse a wasted heat source would involve filtering out existing toxins and smells generated from the kitchen to provide a odour free experience for the customers.

To transfer the heat from the kitchen to the patio area, an outdoor duct would be installed in conjunction with a heat exhaust unit to redirect heat out of the kitchen and into the duct. The air within this duct would undergo filtering through a carbon filter, a common filter used in various industries to remove unwanted odours and volatile organic compounds. This part of the system would require monthly maintenance due to the disposal designed of carbon filters.

In order to evaluate the data a TBL assessment tool was created based off key social, economic, and environmental, indicators and is provided below.

Economic		Enviroment		Social	
Initial Cost	4.0	Production of GHG	5.0	Customer Satisfaction	3.5
Cost for Maintenance	5.0	Lifecycle	3.5	Ease of use	5.0
Running Cost	4.0	Renewable Energy	4.0	Student Body Education	5.0

Table 3.3: TBL Analysis tool

Once the above data was collected, our TBL assessment tool could then be applied to further understand the advantages and disadvantages of each solution. The scoring of each solution is described in the appendix.

4.0 Conclusion & Recommendation

After reviewing the assessments provided above, we concluded that the most effective solution would be a combination of two of the aforementioned technologies. The primary source of heating would stem from a heat recovery system streaming wasted kitchen exhaust towards the patio. Any VOCs such as odorous or chemical compounds would be filtered out prior to distribution via active carbon filtering techniques. Active carbon filters effectively purify air and require little maintenance making it the standard in small scale filtration systems such as this. After this process, the clean air would then be distributed across the patio. To ensure customer satisfaction a secondary source would be implemented, infrared heaters. Infrared heaters provide fast and efficient heat requiring little time to provide its users with prominent heat. To avoid obstruction, the infrared heaters would be mounted above the patio doors where they can be connected to electrical plugins. This setup could be designed to create an even dispersion of heat to ensure that all patio occupants are sufficiently affected. As mentioned above, the patio heaters would be a secondary source, in other words they would be supplementing the heat duct in the case of insufficient heating due to colder outdoor temperatures.

Financially, this solution may appear to require extraneous funds to implement but the long term investment would pay off considerably. Initial costs comprise the majority of the price analysis but maintenance costs would be virtually nonexistent. Usage of wasted heat energy would mitigate electrical costs, though this cost could be further reduced by investing in increased insulation for the heat duct. Investing in a higher upfront cost of quality insulation panels would decrease monthly electric heating costs leading to a long term financially sustainable solution.

Socially, the solution chosen takes into account the various seating layouts allowing for optimal customer satisfaction. The heat supplied from the kitchen exhaust is dependent on kitchen use as well as outdoor temperature. Due to this dependency, supplemental infrared heaters can be utilized to meet target temperatures which will vary due to current weather conditions. Having a permanent heating duct installed and easy to use infrared heaters would allow for the solution to be easily used by staff with minimal training required.

Environmentally, this solution provides a minimal footprint due to constant supply from clean energy sources. Reusing a wasted heat source would allow a net zero energy solution to be implemented and also provide a chance for the Perch to upgrade the LEED status from gold to platinum. Not only does this solution minimally impact the

SUB footprint, but depending on the temperature conditions this system can lower the original SUB carbon output. The infrared heaters also use clean electrical energy efficiently, effectively making this solution the obvious choice when considering sustainability.

Taking these factors into account, the most viable solution for the Perch is incorporating a heat duct with supplemental infrared heaters. The combination of two heating methods allows for optimal customer comfort while further reducing the carbon footprint of an already sustainable building.

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APPENDICES

Solution 1: Solar Panel with electric heater

Economic		**Environment**		**Social**	
Initial Cost	VERY HIGH	Production of GHG	NO	Customer satisfaction	HIGH
Cost for maintenance	HIGH	Lifecycle	LONG	User friendly	YES
Running Cost	LOW	Renewable energy	YES	Student body education	YES

Additional comments: Very high upfront costs

Solution 2: Infrared heaters attached inside umbrellas

Economic		**Environment**		**Social**	
Initial Cost	LOW	Production of GHG	NO	Customer satisfaction	HIGH
Cost for maintenance	LOW	Lifecycle	LONG	User friendly	YES
Running Cost	LOW	Renewable energy	NO	Student body education	NO

Additional comments: With a heater mounted directly above the table, the majority of the heat produce will be directed onto the customers. In order to power the heater, each table needs an electrical connection. Without the ability to change the design of the patio outlets cannot be added, resulting in extension cords running to tables creating a tripping hazard and aesthetic problems.

Solution 3: Kitchen heat duct

Economic		**Environment**		**Social**	
Initial Cost	HIGH	Production of GHG	NO	Customer satisfaction	MED
Cost for maintenance	MED	Lifecycle	LONG	User friendly	YES
Running Cost	NONE	Renewable energy	NO	Student body education	YES

Additional comments: Using the heat produced by the kitchen to warm the rooftop patio uses the thermal energy that normal is vented to the atmosphere. This out of the box solution will require no running cost as all the energy is created in-house.